GCE

Mathematics A

H240/02: Pure Mathematics and Statistics

Advanced GCE

Mark Scheme for Autumn 2021

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Text Instructions

1. Annotations and abbreviations

Annotation in RM assessor	Meaning
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
BP	Blank Page
Seen	
Highlighting	
Other abbreviations in mark scheme	**Meaning**
dep*	Mark dependent on a previous mark, indicated by *. The * may be omitted if only one previous M mark
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working
AG	Answer given
awrt	Anything which rounds to
BC	By Calculator
DR	This question included the instruction: In this question you must show detailed reasoning.

2. Subject-specific Marking Instructions for A Level Mathematics A

a Annotations must be used during your marking. For a response awarded zero (or full) marks a single appropriate annotation (cross, tick, M0 or ^) is sufficient, but not required.

For responses that are not awarded either 0 or full marks, you must make it clear how you have arrived at the mark you have awarded and all responses must have enough annotation for a reviewer to decide if the mark awarded is correct without having to mark it independently.

It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

Award NR (No Response)

- if there is nothing written at all in the answer space and no attempt elsewhere in the script
- OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
- OR if there is a mark (e.g. a dash, a question mark, a picture) which isn't an attempt at the question.

Note: Award 0 marks only for an attempt that earns no credit (including copying out the question).

If a candidate uses the answer space for one question to answer another, for example using the space for 8(b) to answer 8(a), then give benefit of doubt unless it is ambiguous for which part it is intended.

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct solutions leading to correct answers are awarded full marks but work must not always be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly. Correct but unfamiliar or unexpected methods are often signalled by a correct result following an apparently incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
If you are in any doubt whatsoever you should contact your Team Leader.

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.
A method mark may usually be implied by a correct answer unless the question includes the DR statement, the command words "Determine" or "Show that", or some other indication that the method must be given explicitly.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep*' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, what is acceptable will be detailed in the mark scheme. If this is not the case please, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f We are usually quite flexible about the accuracy to which the final answer is expressed; over-specification is usually only penalised where the scheme explicitly says so.

- When a value **is given** in the paper only accept an answer correct to at least as many significant figures as the given value.
- When a value **is not given** in the paper accept any answer that agrees with the correct value to **3 s.f.** unless a different level of accuracy has been asked for in the question, or the mark scheme specifies an acceptable range.
  NB for Specification B (MEI) the rubric is not specific about the level of accuracy required, so this statement reads "2 s.f".

Follow through should be used so that only one mark in any question is lost for each distinct accuracy error.
Candidates using a value of 9.80, 9.81 or 10 for *g* should usually be penalised for any final accuracy marks which do not agree to the value found with 9.8 which is given in the rubric.

g Rules for replaced work and multiple attempts:

- If one attempt is clearly indicated as the one to mark, or only one is left uncrossed out, then mark that attempt and ignore the others.
- If more than one attempt is left not crossed out, then mark the last attempt unless it only repeats part of the first attempt or is substantially less complete.
- if a candidate crosses out all of their attempts, the assessor should attempt to mark the crossed out answer(s) as above and award marks appropriately.

h For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A or B mark in the question. Marks designated as cao may be awarded as long as there are no other errors.
If a candidate corrects the misread in a later part, do not continue to follow through. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i If a calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers, provided that there is nothing in the wording of the question specifying that analytical methods are required such as the bold "In this question you must show detailed reasoning", or the command words "Show" or "Determine". Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

j If in any case the scheme operates with considerable unfairness consult your Team Leader.

Question			Answer	Mark	Guidance
1	(a)		$-4e^{-4x}$ oe	B2 [2]	B1 for e^{-4x} seen as part of answer, not in denominator
1	(b)		By quotient rule $\frac{(x+1)\times 2x - x^2 \times 1}{(x+1)^2}$	B1 B1	B1: correct denominator & 1 correct term in numerator, any form ISW
			Alternative method – chain rule or $-(x+1)^{-2} \times x^2 + (x+1)^{-1} \times 2x$	B1 B1	B1 for either term correct ISW
			$(= \frac{x(x+2)}{(x+1)^2}$ or $\frac{x^2+2x}{x^2+2x+1})$	 [2]	
2			f(x) is positive on both sides of the 1st root oe Curve does not cross the x-axis (near root) Sign does not change (near the root) No negative value (near the root)	B2 [2]	B1 for "The graph touches the x-axis" or "repeated root" or "It is a stationary point" Ignore all else, eg "inflection"
3			$a + 14d = 88$ (i) $\frac{10}{2}(2a + 9d) = 310$ (ii) Substitute from (i) into (ii) $\frac{10}{2}(2(88 - 14d) + 9d) = 310$ $176 - 19d = 62$ $d = 6$, $a = 4$	M1 A1 M1 A1 M1 A1 [6]	M1 for one error, eg $a + 9d = 88$ M1 for $\frac{15}{2}(2a + 14d) = 310$ or for one error, eg $5(2a + 18d) = 310$ Attempt substitution, elimination or to verify solutions found BC. Condone one arithmetical error SC for last 2 marks: Correct answers, substitution not seen: B1B0, dep M1M1 cao

Question			Answer	Mark	Guidance
4	(a)		6000	B1 [1]	
4	(b)		2000	B1f [1]	ft their (a) − 4000
4	(c)		Oscillates or Goes up and down. oe Fluctuates. Moves in a cycle	B1 [1]	Ignore all else NOT "Increases for 1st 6 months then decreases"
4	(d)		$30t = 360$ Time to return to initial size = 12 months	M1 A1 [2]	May be implied by answer Allow $t = 12$, or $t = 12$ months, or just 12
4	(e)		$4500 = 5000 - 1000\cos(30t)^\circ$ $\cos(30t)^\circ = 0.5$ $30t = 60$ or 300 (both) 2nd time $P = 4500$ is when $t = 10$	M1 A1 M1 A1	Substitute $P = 4500$ May be implied by next line Correct rearrangement Attempt $30t = \cos^{-1}$(their 0.5), giving α and $360 - \alpha$. Condone $30t = \frac{\pi}{3}, \frac{5\pi}{3}$ or after 10 months. Allow $t = 10$ months, or just 10 SC. (If not gained 1st M1A1)Correct answer with no or inadequate working and/or T&I: $t = 10$ stated: B2; $t = 10$ embedded: B1B0
			Alternative methods for 2nd M1A1 $30t = 60$ or -60 (both) (t = 2 or −2) 2nd time $P = 4500$ is when $t = -2 + 12 = 10$	 M1 A1	 $30t = 60$ ($t = 2$) (end of 1st cycle at $t = 12$) 2nd time $P = 4500$ is when $t = 12 - 2 = 10$
			$30t = 60$ ($t = 2$) $6 - 2 = 4$; $t = 6 + 4 = 10$	M1 A1	
				[4]	
4	(f)		eg $P = 5000 - 1000e^{-t}\cos(30t)^\circ$ $P = 5000 - 1000e^{-kt}\cos(30t)^\circ$ ($k > 0$) Answers in words must be equivalent to one of these	B1 [1]	or other good answers eg $P = 5000 - (1000\cos(30t)^\circ)^{1/t}$ $P = 5000 - \frac{1000}{t}\cos(30t)^\circ$. ($t > 0$)

Question			Answer	Mark	Guidance
5	(a)		Midpoint AB is (3.5, 5.5); Gradient $AB = -\frac{1}{7}$	B1	Both. Allow midpoint = $(\frac{0+7}{2}, \frac{6+5}{2})$ ISW
			Gradient of perpendicular bisector $-1/(-\frac{1}{7})$	M1	(= 7)
			$y - 5.5 = 7(x - 3.5)$ oe ISW	A1	cao. Correct answer, no working or inadequate working: SC B2
			Midpt AB is (3.5, 5.5); Gradient $AB = -\frac{1}{7}$	B1	Both
			$(y = 7x + c)$ $5.5 = 7\times 3.5 + c$	M1	ft their midpt and gradient, NOT $-\frac{1}{7}$
			$y = 7x - 19$	A1	cao. Any correct form
			$x^2 + (y - 6)^2 = (x - 7)^2 + (y - 5)^2$	M1	
				M1	Attempt expansion
			$-12y + 36 = -14x - 10y + 49 + 25$ ISW	A1	cao. Any correct form eg $y = 7x - 19$
				[3]	
5	(b)		Perpendicular bisector of BC is $x + 7y - 17=0$ OR of CA is $4y = 3x - 1$	B1	Any correct form for another perp bisector
			Example method, perp bisectors of AB & BC:		
			$x + 7(7x - 19) - 17 = 0$ $(\Rightarrow x = 3)$	M1	Attempt solve simultaneously equations of two perpendicular bisectors. Can be implied
			Alternative method for 1st two marks	M1	
			Grad BC is 7 so BC & AB perpendicular		
			Hence AC is a diameter	B1	
			Centre is (3, 2)	B1	cao. NB, if centre = (3, 2) without clear working, B0M0B1
			eg Radius$^2 = 3^2 + (6 - 2)^2 = 25$	M1	Correct method for r^2 or r using their centre & A or B or C
			Equn of circle is $(x - 3)^2 + (y - 2)^2 = 25$ or $x^2 - 6x + y^2 - 4y = 12$ oe	A1ft	ISW. ft their centre & radius, dep both M1 marks
				[5]	

Question			Answer	Mark	Guidance
6	(a)		$0.1(1 + 1.1^2 + 1.2^2 + 1.3^2 + 1.4^2)$ $0.1(1.1^2 + 1.2^2 + 1.3^2 + 1.4^2 + 1.5^2)$	**B1** **[1]**	NB. Check working Both seen oe
6	(b)		0.79 About half way between the last two bounds or $(0.784 + 0.799) \div 2 = 0.79$ Ignore all else	**B1** **B1** **[2]**	Not 0.7915 condone "The mean of the last two bounds" or other sensible Allow UB and LB are converging towards 0.79 oe The two B1 marks are independent
6	(c)		$\lim_{\delta x \to 0} \sum_{x=1}^{1.5} y\delta x$	**B1** **B1**	for $\lim_{\delta x \to 0} \sum y\delta x$. Allow x^2 instead of y for limits, dep using Σ not integral. $\lim_{\delta x \to 0} \sum_{1}^{1.5} y\delta x$ B1B0
7			$\cos(x + \delta x) - \cos x$ $= \cos x \cos \delta x - \sin x \sin \delta x - \cos x$ $\lim_{\delta x \to 0} \frac{\cos x \cos \delta x - \sin x \sin \delta x - \cos x}{\delta x}$ as $\delta x \to 0$: $\cos \delta x \to 1$ or $1 - \frac{(\delta x)^2}{2}$ and $\frac{\sin \delta x}{\delta x} \to 1$ or $\sin \delta x \to \delta x$ $(\lim_{\delta x \to 0} \frac{\cos x - \sin x \delta x - \cos x}{\delta x})$ $= -\sin x$	 **B1** **M1** **M1** **A1**	Allow h or other letter for δx throughout or $\lim_{\delta x \to 0} \frac{\cos(x+\delta x) - \cos x}{\delta x}$ or may be seen later. Must include $\lim_{\delta x \to 0}$. Allow $\cos \delta x = 1$ for small δx (or $1 - \frac{(\delta x)^2}{2}$) Allow $\sin \delta x = \delta x$ for small δx Both must be explicitly stated for M1 If not stated but implied, M0, but can still possibly gain final A1 Dep on at least B1M1 gained, and approximations either seen explicitly or seen substituted. and nothing incorrect seen NB. $\cos x - \sin x - \cos x = -\sin x$ is incorrect and scores A0

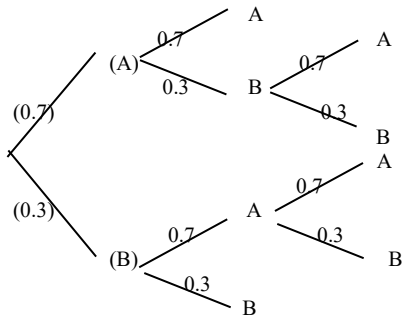
Question			Answer	Mark	Guidance
				[4]	
8	(a)		$b = -1,\ c = 1$	B1 [1]	or $(n + 1)(n^2 - n + 1)$
8	(b)		$n + 1$ (or $n^2 - n + 1$) is a factor of K	B1	Stated. Allow x instead of n NOT $n^3 + 1$ can be expressed as $(n+1)(n^2-n+1)$
			$n > 2$ so $n + 1 > 1$ or $n + 1 > 3$ or $n + 1 \neq 1$ ($n^2 - n + 1$ is a factor of K and $n^2 - n + 1 > 1$ or $\neq 1$)	B1	Must see $n > 2$ Allow omission of this step
			Assume these factors are equal Let $n^2 - n + 1 = n + 1$ $\Rightarrow n^2 - 2n = 0$	M1	
			$n = 0$ or 2.	A1	
			$n > 2$ so both invalid; hence 2 distinct factors	A1	Conclusion stated, from correct working seen. Dep at least B1M1 and correct reasoning given
			Ignore attempted proofs that either factor $\neq K$		SC: $(n+1) > 1$ or $n + 1 > 3$ (or $n^2 - n + 1 > 1$) B1 $(n+1)$ & $(n^2 - n + 1)$ are factors of K B1
				[5]	
9	(a)		**Summary method:**		
			$\overrightarrow{OM} = \frac{1}{2}(\mathbf{b} + \mathbf{c})$ or $\mathbf{b} + \frac{1}{2}(-\mathbf{b} + \mathbf{c})$ oe	B1	Can be implied
			$\overrightarrow{AM}$ or $\overrightarrow{MA}$ attempted in terms of **a**, **b** and **c** $(= \pm(\frac{1}{2}(\mathbf{b} + \mathbf{c}) - \mathbf{a})$ oe)	M1	May be included in working, eg $\overrightarrow{AX} = \frac{2}{3}(\frac{1}{2}(\mathbf{b} + \mathbf{c}) - \mathbf{a})$ Not necessarily correct
			$\overrightarrow{OX} = \mathbf{a} + \frac{2}{3}\overrightarrow{AM}$ or $\overrightarrow{OM} + \frac{1}{3}\overrightarrow{MA}$ oe attempted in terms of **a**, **b** and **c**	M1	Not necessarily correct
			$\overrightarrow{OX} = \frac{1}{3}(\mathbf{a} + \mathbf{b} + \mathbf{c})$	A1	or equivalent simplified form

Question			Answer	Mark	Guidance
9	(a)		**Examples of methods using the above**		**Other correct methods may be seen** Allow inadequate notation
	ctd		$\overrightarrow{OM} = \frac{1}{2}(\mathbf{b}+\mathbf{c})$	B1	
			$\overrightarrow{AX} = \frac{2}{3}\overrightarrow{AM} = \frac{2}{3}(\frac{1}{2}(\mathbf{b}+\mathbf{c})-\mathbf{a})$	M1	for $\overrightarrow{AM} = (\frac{1}{2}(\mathbf{b}+\mathbf{c})-\mathbf{a})$ implied
			$\overrightarrow{OX} = \mathbf{a} + \frac{2}{3}\overrightarrow{AM} = \mathbf{a} + \frac{2}{3}(\frac{1}{2}(\mathbf{b}+\mathbf{c})-\mathbf{a})$	M1	
			$= \frac{1}{3}(\mathbf{a}+\mathbf{b}+\mathbf{c})$	A1	
			$\overrightarrow{BM} = \frac{1}{2}(-\mathbf{b}+\mathbf{c})$		
			$\overrightarrow{AM} = \overrightarrow{AO} + \overrightarrow{OB} + \overrightarrow{BM}$		
			$= -\mathbf{a} + \frac{1}{2}\mathbf{b} + \frac{1}{2}\mathbf{c}$	B1 M1	Implied
			$\overrightarrow{OX} = \mathbf{a} + \frac{2}{3}(-\mathbf{a} + \frac{1}{2}\mathbf{b} + \frac{1}{2}\mathbf{c})$	M1	
			$= \frac{1}{3}(\mathbf{a}+\mathbf{b}+\mathbf{c})$	A1	
			$\overrightarrow{OM} = \frac{1}{2}(\mathbf{b}+\mathbf{c})$	B1	
			$\overrightarrow{XM} = \frac{1}{3}\overrightarrow{AM}$		
			$= \frac{1}{3}(\frac{1}{2}(\mathbf{b}+\mathbf{c})-\mathbf{a})$	M1	for $\overrightarrow{AM} = (\frac{1}{2}(\mathbf{b}+\mathbf{c})-\mathbf{a})$ implied
			$\overrightarrow{OX} = \overrightarrow{OM} - \frac{1}{3}\overrightarrow{AM}$		equivalent to $\overrightarrow{OM} + \frac{1}{3}\overrightarrow{MA}$
			$= \frac{1}{2}(\mathbf{b}+\mathbf{c}) - \frac{1}{3}(\frac{1}{2}(\mathbf{b}+\mathbf{c})-\mathbf{a})$	M1	
			$= \frac{1}{3}(\mathbf{a}+\mathbf{b}+\mathbf{c})$	A1	

Question			Answer	Mark	Guidance
				[4]	
9	(b)		$\overrightarrow{OF}$ = **a** + **b** + **c** Hence *X* lies on *OF*, so *AM* and *OF* intersect	B1* B1dep [2]	Both statements needed. NB dep on B1
10	(a)		Very likely weight will increase with time oe or He is only looking for positive correlation	B1 [1]	Or eg "Expect weight to increase with time" oe "Foetuses grow" oe Ignore all else
10	(b)		H_0: $\rho = 0$ Allow other letters H_1: $\rho > 0$ where ρ is the correlation coefficient for the population or where ρ is the correlation coefficient between time and weight Comp 0.722 with 0.6851 Reject H_0. Condone Accept H_1 There is evidence of (positive linear) correlation between time from conception to birth and weight of new-born babies Or eg It appears that birth weight increases with time (from conception to birth)	B1 B1 M1 M1 A1 [5]	**B1B0** for 1 error, eg undefined ρ or 2-tail For hypotheses in words, not using parameter: H_0: There is no correlation between time and weight H_1: There is positive correlation between time and weight **B1B0** But omission of "positive": **B0B0** May be implied by conclusion Allow without "positive" and without "linear" In context, not definite
11	(a)		Population large oe	B1	or, eg Would take too long to contact all students.

Question			Answer	Mark	Guidance
				[1]	NOT "Easier"
11	(b)		eg: Includes students from all years (or ages) Numbers in years in correct proportions Different years might like different music	B1 [1]	or: Different years may have different numbers of students NOT "It's more representative" or "Takes all students into account" "You get a range of people" "It avoids bias"
11	(c)		$21 + 2\times4.2 = 29.4$ $22.9 + 1.5(22.9 - 18.0) = 30.25$ Unclear whether 30 is an outlier	B1 B1 B1 [3]	Allow "30 is more than 2 sds away from the mean" Allow "30 is less than 1.5×IQR from UQ" or eg "It depends which definition you use." Any comment implying uncertainty Ignore comments about mean ± 3 sds or mean ± 1 sd
11	(d)		$H_0: \mu = 20$ $H_1: \mu > 20$ where μ = pop mean time spent oe $\bar{X} \sim N(20, \frac{4.2^2}{60})$ and $\bar{X} = 21$ $P(\bar{X} > 21) = 0.0326$ Compare 0.05	 B1 B1 M1 A1 A1	**NB Allow 2 sf throughout** Allow other letters, not X unless defined. Not $\bar{X}$ **B1B0** for 1 error eg 2-tail or: 2-tail B1B0 μ = sample mean implied B1B0 undefined μ B1B0 Not include value 20 B0B0 not in terms of parameter B1B0 eg $H_0 = 20$ etc: B0B0 Correct distribution and value of $\bar{X}$. stated **or implied** eg by 0.0326 or 0.967 or 20.9 or 1.84 or0.000335 even if within incorrect statement eg $P(X = 21) = 0.0326$ Condone $\frac{4.2^2}{\sqrt{60}}$ or $\frac{4.2^2}{60^2}$ or $\frac{4.2}{60}$ **BC** Allow 2 sf, ie 0.033 Dep 0.0326 or 1.84 or 0.9674 or $P(X > 21)$ or $P(X \geq 21)$ soi Must compare like with like,

Question			Answer	Mark	Guidance
					eg NOT prob cf z-value or large prob cf small prob or CV cf wrong end of acceptance region
11	(d)		**Alternative methods for M1A1A1**		
	ctd		or $\frac{a-20}{4.2\div\sqrt{60}} = 1.645$ ($a = 20.9$)	**M1**	Condone $\frac{4.2^2}{\sqrt{60}}$ or $\frac{4.2^2}{60^2}$ or $\frac{4.2}{60}$
			CV = 20.9	**A1**	
			21 > 20.9 or 21 not in acceptance region	**A1**	
			or $\frac{21-20}{4.2\div\sqrt{60}}$ (= 1.84)	**M1**	Condone $\frac{4.2^2}{\sqrt{60}}$ or $\frac{4.2^2}{60^2}$ or $\frac{4.2}{60}$
			$z_{calc} = 1.84$	**A1**	
			Compare 1.645	**A1**	
			$\bar{X} \sim N(20, \frac{4.2^2}{60})$ and $\bar{X} = \frac{1260}{60}$ or 21	**M1**	Condone $\frac{4.2^2}{\sqrt{60}}$ or $\frac{4.2^2}{60^2}$ or $\frac{4.2}{60}$
			$P(\bar{X} < 21) = 0.9674$	**A1**	**BC**
			Compare 0.95	**A1**	
			Reject H_0 Condon Accept H_1	**M1**	Dependent on clearly valid comparison of like with like. Dep 0.0485 or 0.951 or 20.9 or 1.84 or $P(X > 21)$ or $P(X \geq 21)$ soi May be implied by conclusion, eg "There is evidence that mean time is > 20 hours" **M1A1**
			There is evidence that (mean) time spent is > 20 hours or eg there is evidence to support Zac's belief	**A1f**	In context, not definite; eg "Mean time is > 20 hours": **A0** But "There is evidence to reject H_0 and that mean time is > 20 h"

Question			Answer	Mark	Guidance
				[7]	**M1A1** Allow opposite conclusion, ft their values, if above conditions met
			NB Use of $4.2^2/60$ as sd gives $p = 0.000335$		and loses 2nd A1. But potentially can score all the other 6 marks
12	**(a)**		0	**B1** **[1]**	Allow 0%
12	**(b)**			**B1** **B1** **B1** **[3]**	Ignore extra branches if no probabilities or $p = 0$ B2: 8 correct branches and probs OR names, no extra branches B2: 7 correct branches, probs and names, no extra branches B1: 8 correct branches without probs & names. No extra branches B1: 6 correct branches, probs and names. Ignore extra branches Ignore products at ends
12	**(c)**		$0.3\times0.3 + 0.7\times0.3\times0.3 + 0.3\times0.7\times0.3$ **or** $0.09 + 0.063 + 0.063$ oe $= \frac{27}{125}$ or 0.216	**M1** **M1** **A1** **[3]**	All correct M2 ft their diagram Two products correct M1 ft their diagram SC Correct answer with no working: B2
12	**(d)**		$0.7 \times 0.3 + 0.3 \times 0.7$ or $0.21 + 0.21$ $= \frac{21}{50}$ or 0.42	**M1** **A1** **[2]**	or $1 - (0.7^2 + 0.3^2)$ or $1 - (0.49 + 0.09)$ Condone missing brackets or $0.7\times0.3\times0.7 + 0.7\times0.3\times0.3 + 0.3\times0.7\times0.7 + 0.3\times0.7\times0.3$ oe or $2 \times 0.147 + 2\times 0.063$ oe Wholly correct method ft their diagram SC Correct answer with no working: B1
12	**(e)**		P(B wins and 3 points) $= 0.7\times0.3\times0.3 + 0.3\times0.7\times0.3$ or 2×0.063 (= 0.126 oe) $\frac{\text{P(B wins \& 3 points)}}{\text{P(B wins)}} = \frac{'0.126'}{'0.216'}$	 **M2** **M1**	ft their diagram for M-marks soi M1 for one correct product or 0.063 Must attempt $\frac{\text{P(B wins \& 3 points)}}{\text{Their (c) NOT (d) or } 0.3\times0.3+0.7\times0.3\times0.3+0.3\times0.7\times0.3}$

Question			Answer	Mark	Guidance
			$= \frac{7}{12}$	**A1** **[4]**	Allow 0.583 (3 sf) SC no working $\frac{7}{12}$ B2 But minimal working is OK, eg $\frac{2\times0.063}{0.216} = \frac{7}{12}$ M2M1A1
13	**(a)**		A: High private and low public **OR** B: Low bicycle and low public **OR** B: Low bicycle and high private **OR** C: Low bicycle and high private	**B2** **[2]**	Allow B1 for A or B or C with one correct factor only. Ignore else All answers can be implied Ignore all else
13	**(b)**		Pie charts allow comparison of proportions Pie charts show proportions oe Ignore all else	**B1** **[1]**	NOT: Bar charts don't show proportions unless also state pies do. Assume "They" means pie charts. NOT: It's easier to compare data Pie charts don't easily show which is greatest Allow percentages instead of proportions
13	**(c)**	**(i)**	C and D Larger (or high or most) proportion public transport Can be implied. Ignore all else	**B1** **B1** **[2]**	Both, no others Dep applied to at least one of C and D, even if other LA mentioned B-marks are independent
13	**(c)**	**(ii)**	**LDS says "The method of travel used is for the longest part, by distance, of the usual journey to work"** **Correct answers therefore should assume users of P&R will report only private, not public**		
			Method of travel is the type used for the longest part of the journey Most people using Park-and-Ride would still	**B1**	"Disagree" may be implied

Question			Answer	Mark	Guidance
13	(c)	(ii) ctd	say they were using private transport.	B1	independent Ignore all else
			People will still have to travel by car, so the results won't be very different	B2	
			Alternatives, assuming (incorrectly) users of P&R will report both methods or just public:		
			Public transport increase or private decrease	B1 B0	"Agree" may be implied Ignore all else
			P&R will result in more people using private transport, so this will show an increase	B1 B0	Not just "Increase in private" without justification
			Users of P&R will use both public and private, so not clear	B1 B0	
			No, because other changes might have been made that affect the proportions.	B2	
			If P&R users report both, or just public, then yes, public will show increase	B2	
			Recognition of issue as to whether P&R users should report private or public Hence unclear whether change will show	B1 B1	Other sensible answers may be seen not covered in this MS
				[2]	
14	(a)		$k(1 + \frac{1}{2}+\frac{1}{3}+\frac{1}{4}) = 1$	M1	
			$k \times \frac{25}{12} = 1$ or eg $\frac{25}{3}k = 4$ or $25k = 12$.		Correct equation involving multiple of k
			hence $k = \frac{12}{25}$ **AG**	A1	Must see previous line and answer

Question			Answer	Mark	Guidance
			or verification: $\frac{12}{25} + \frac{6}{25} + \frac{4}{25} + \frac{3}{25} = 1$	M1 A1	
				[2]	
14	(b)		1 2 3 4 $\frac{12}{25}$ $\frac{6}{25}$ $\frac{4}{25}$ $\frac{3}{25}$	B1	or equivalent exact values
				[1]	
14	(c)		(3, 1, 1) (4, 1, 1) (4, 2, 1) (4, 1, 2)	M1	At least three of these seen or implied. No extras or repeats.
			$\frac{4}{25} \times (\frac{12}{25})^2 + \frac{3}{25} \times (\frac{12}{25})^2 + \frac{3}{25} \times \frac{6}{25} \times \frac{12}{25}$ $+ \frac{3}{25} \times \frac{12}{25} \times \frac{6}{25}$ oe	M1	At least two correct terms, no incorrect coefficients; ft their table. Allow in terms of k
			$= \frac{288}{3125}$ or 0.09216	A1	Allow 0.0922 (3 sf)
				[3]	
14	(d)		(1, 1, 1, 1, 3)	B1	B1B1 for both sets in any order, without extras. Both soi.
			(1, 1, 1, 2, 2)	B1	B1 for both sets in any order, with extras.
			$(\frac{12}{25})^4 \times \frac{4}{25} \times 5 + (\frac{12}{25})^3 \times (\frac{6}{25})^2 \times {}^5C_2$ oe	M1	$(\frac{12}{25})^4 \times \frac{4}{25}$ or $(\frac{12}{25})^3 \times (\frac{6}{25})^2$ oe seen. Ignore coeffs. ft their table
				A1	For either $(\frac{12}{25})^4 \times \frac{4}{25} \times 5$ or $(\frac{12}{25})^3 \times (\frac{6}{25})^2 \times {}^5C_2$ oe ft their table
			Alternative method for M1A1		
			or $(\frac{12}{25})^4 \times \frac{4}{25} \times (4+1) + (\frac{12}{25})^3 \times (\frac{6}{25})^2 \times ({}^4C_2+4)$	M1	oe
				A1	For either $(\frac{12}{25})^4 \times \frac{4}{25} \times (4+1)$ or $(\frac{12}{25})^3 \times (\frac{6}{25})^2 \times ({}^4C_2+4)$ oe
			$= \frac{41472}{390625}$ or 0.10616832	A1	Allow 0.106 (3 sf)
				[5]	

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